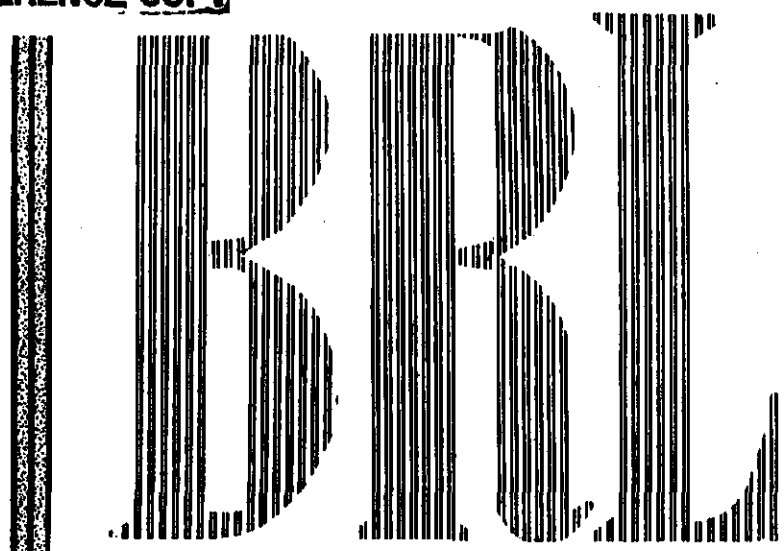

TECHNICAL NOTE No. 840

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Peak Pressure Measurements of a Diffracted Shock Wave

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WESLEY CURTIS

DEPARTMENT OF THE ARMY PROJECT No. 503-04-002
ORDNANCE RESEARCH AND DEVELOPMENT PROJECT No. TB3-0112

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ABERDEEN PROVING GROUND, MARYLAND

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TECHNICAL NOTE No. 840

AFSWP No. 724

GCoulter/WCurtis/ddh
Aberdeen Proving Ground, Md.
January 1954

PEAK PRESSURE MEASUREMENTS OF A DIFFRACTED SHOCK WAVE

ABSTRACT

Pressure versus time records of the shock wave diffracted through a slit are presented. For the particular geometry and pressure range tested a pressure decrease of approximately 60% was recorded in the diffracted wave. Accuracy of measurement, however, was very low and further work awaits improvements in gauge and experimental techniques.

DESCRIPTION OF EXPERIMENT

At the present state of the art of making air blast pressure-time measurements on small models in a shock tube, the piezoelectric gauge recording of blast loading on exterior surfaces of essentially solid models has become routine at the BRL Shock Tube Facility. However, similar measurements on inside surfaces of hollow models have not been successful. The inherent limitation is the size of a satisfactory gauge. The gauge size determines the model wall thickness and the overall size which is in turn limited by the size of the shock tube.

As a first experiment, an 1/8 inch thick wall cut with two 1/8 inch wide slits which had been placed in the 4 1/2 inch shock tube normal to the flow for another program was instrumented with a barium titanate pressure gauge as shown in Fig. 1. Considerable vibration of the thin wall could not be avoided.

Comparison of the pressure versus time record of the shock wave incident at the wall or model before reflection (i.e. as though no wall were present) to the pressure-time record of the gauge on the inside wall surface is shown in Fig. 2. The bottom trace in Fig. 2 shows the effect of reflection and diffraction of this step shock as recorded on the downstream side of the wall. The vibration of the wall and the gauge is apparent in the record tracings. Several other records at the same gauge position are traced in Fig. 3.

The first small peak of vibration may be associated with the shock striking the wall and the gauge casing in which the crystal element is mounted. The second, and largest, peak is taken to be the peak pressure of the diffracted shock. The third peak may be the wave from the upper slit which is further from the gauge. (See the sketch, Fig. 1).

The remainder of the trace is quite difficult to interpret since the vibrations are thoroughly mixed with the pressure record.

Several shots were fired using this experimental set-up and varying the incident shock wave peak pressure from about 3 to 12.5 lbs/in^2. Pressures recorded on the gauge inside the wall over this range of incident shock pressures are plotted in Fig. 4. The scatter is quite large showing an error of approximately plus or minus 20% in any individual measurement. However, it is indicated that the peak pressure of a step shock incident to this particular geometry is deceased to about 60% of its original value due to diffraction by the slit. The wave form is changed radically from the step shock configuration to a rapidly decaying peaked shock wave. The original 3 or 4 millisecond step shock duration is reduced to less than 1 millisecond total duration after diffraction. Although this duration was recorded only at the one gauge position, presumably the duration should increase with distance from the slit as the pressure decreases.

CONCLUSION

Pressure-time records have been made of a shock wave diffracted through a slit in a wall placed in a shock tube normal to the direction of shock propagation. The gauge was located in the wall near the slit. The records for the particular geometry and pressure range used indicate a great decrease in pressure after diffraction and an even greater change in wave shape. However, it must be concluded that the gauges used are not sufficiently free of vibration or acceleration effects to be used generally for the measurements of pressures within hollow models. As the art of making satisfactory vibration-free gauges smaller and smaller continues together with the improvements in model manufacturing techniques, some limited work on hollow models in a 2-foot diameter shock tube may become feasible.

George Coulter
GEORGE COULTER

WESLEY CURTIS

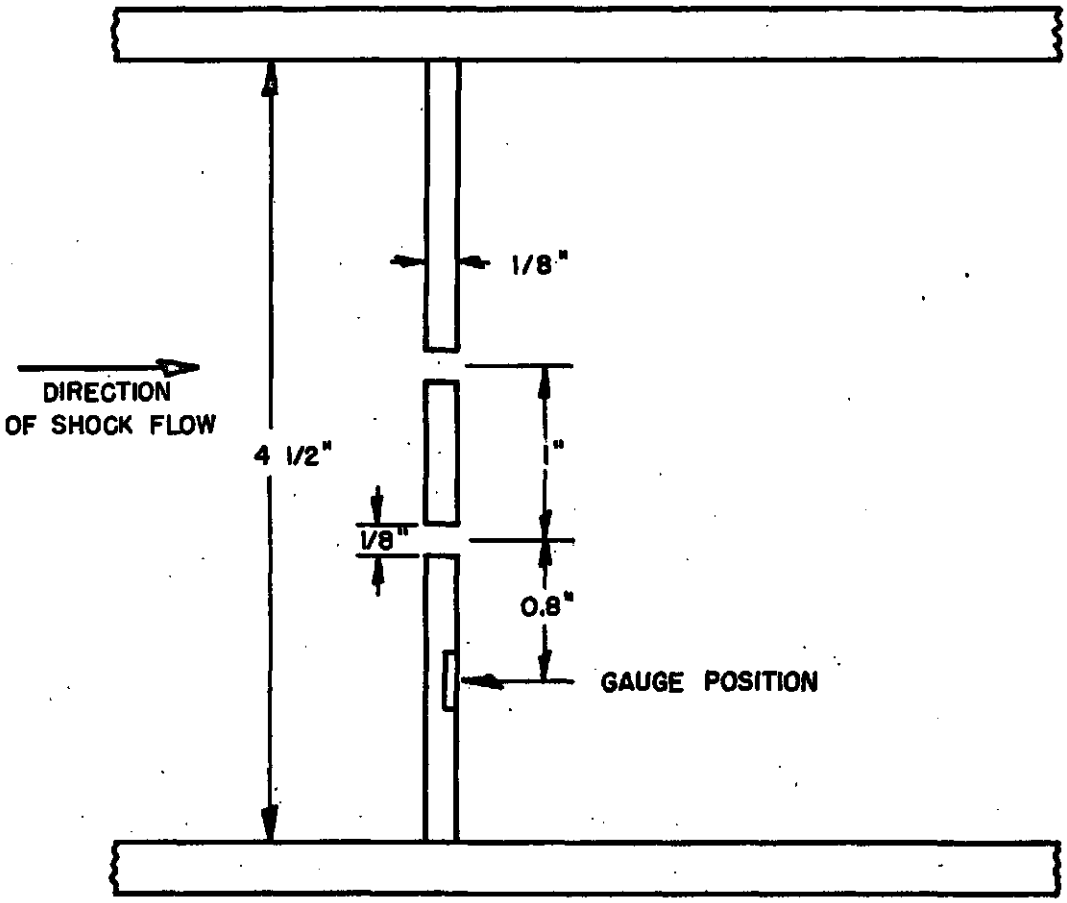


FIG. 1
SKETCH OF GAUGE LOCATION
AND WALL DIMENSIONS

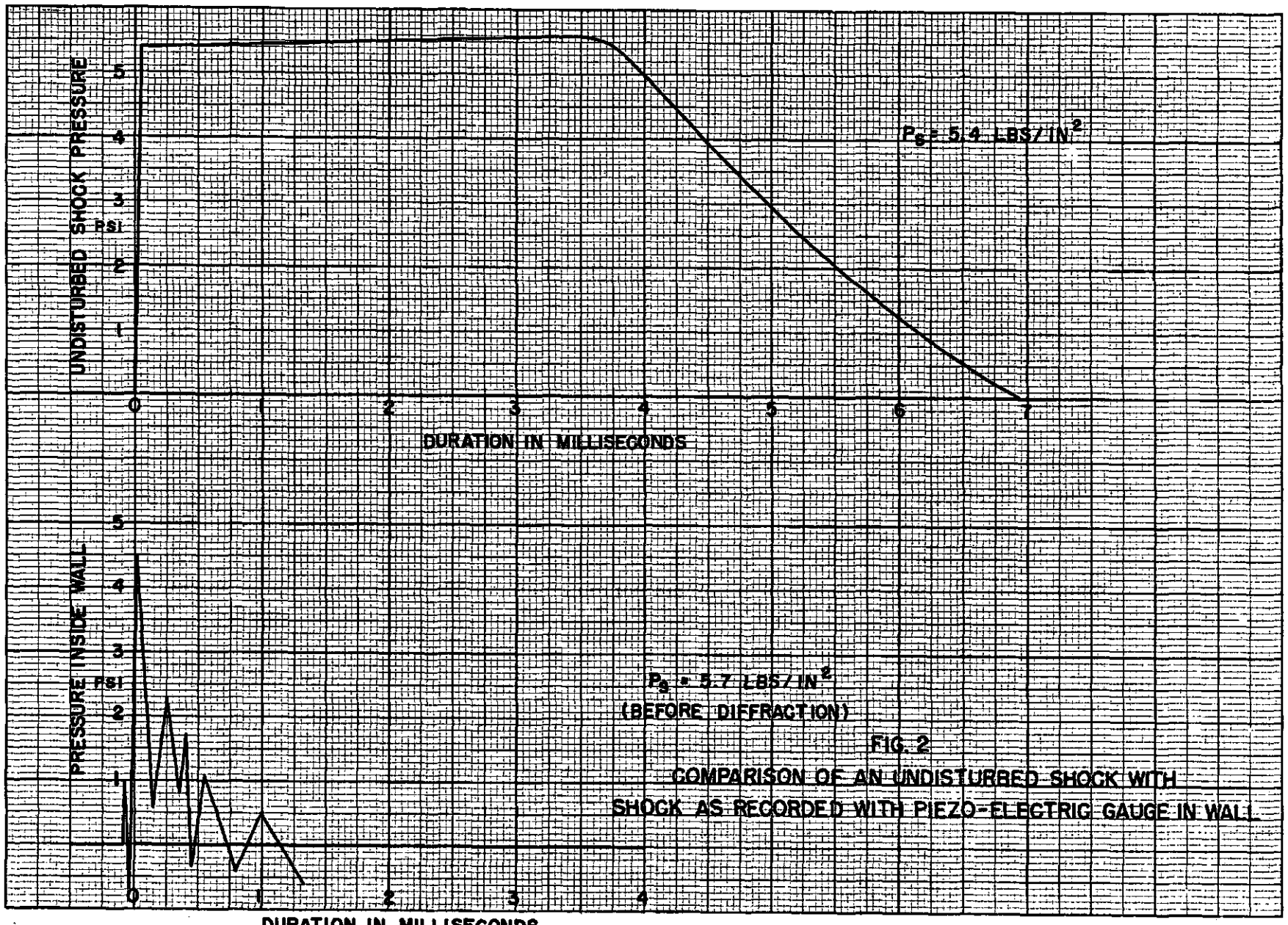


FIG. 2

COMPARISON OF AN UNDISTURBED SHOCK WITH SHOCK AS RECORDED WITH PIEZO-ELECTRIC GAUGE IN WALL

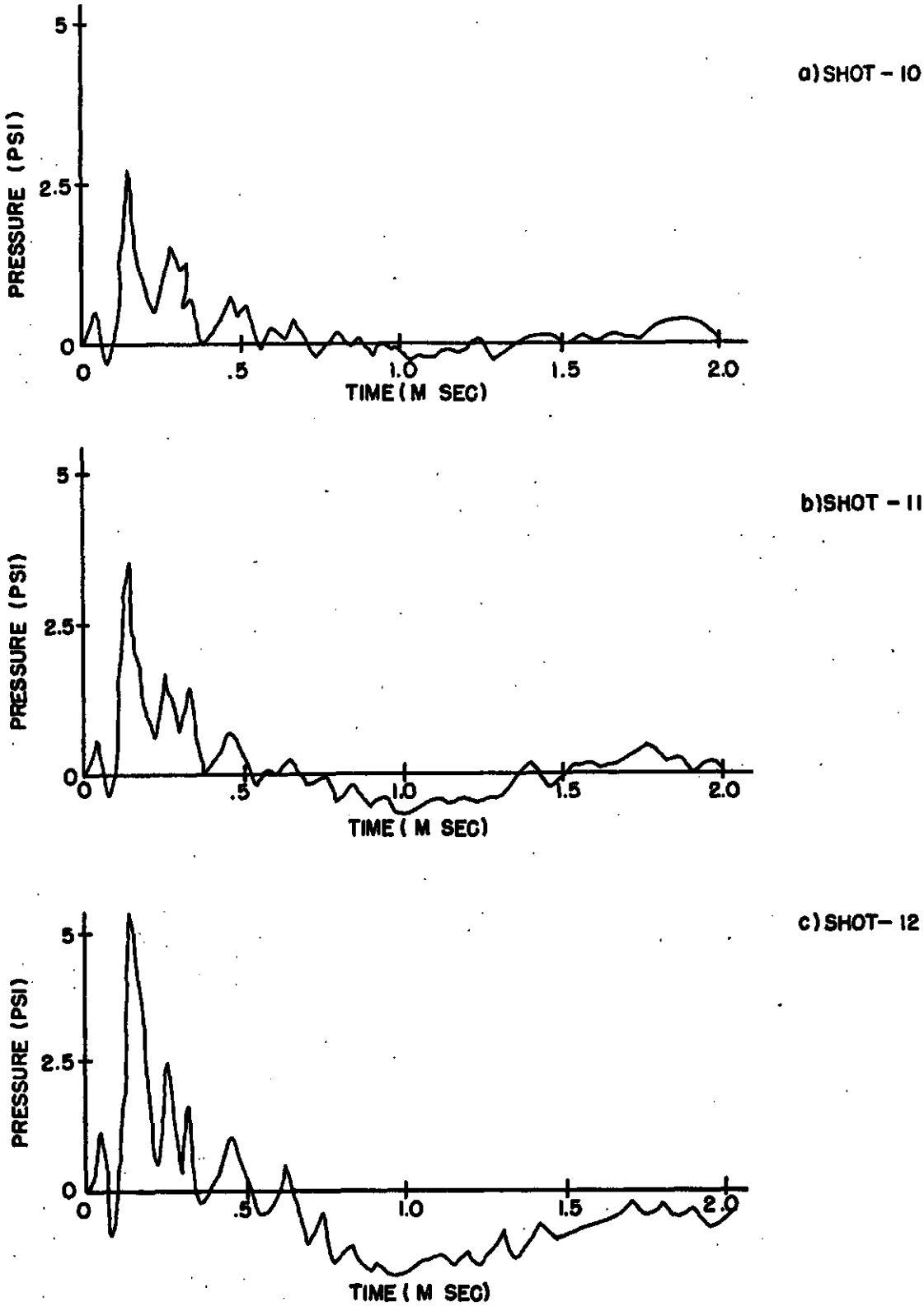
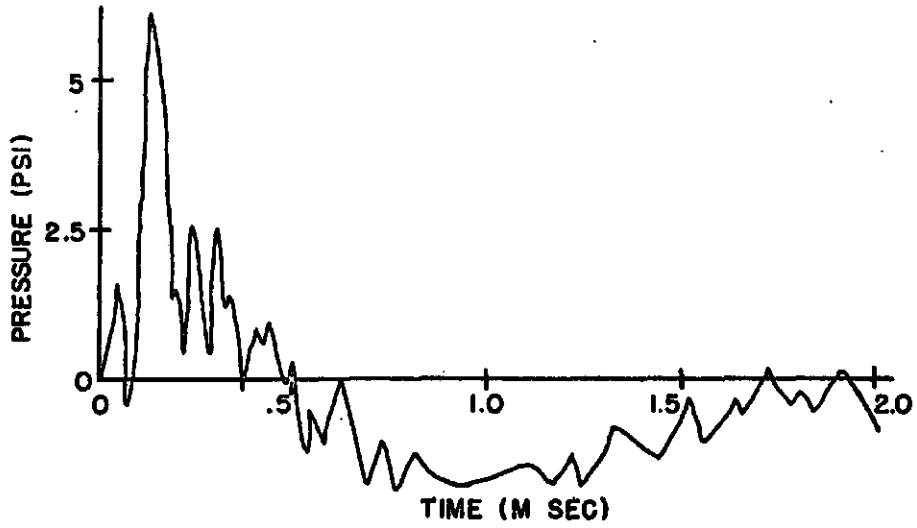
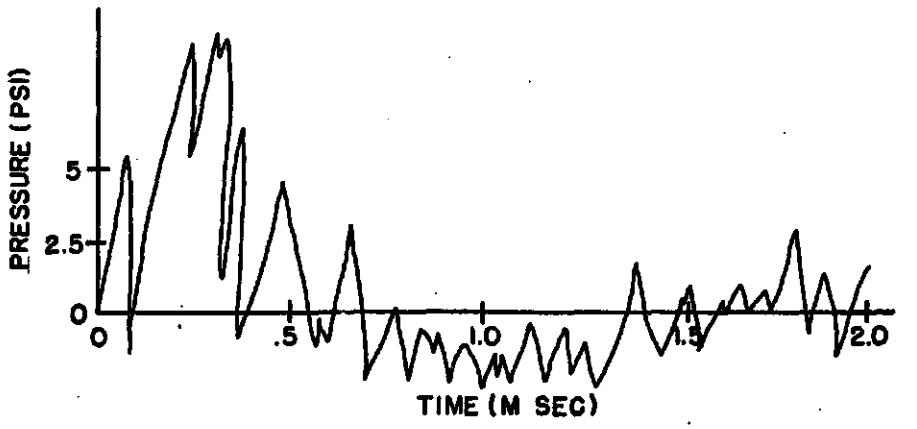


FIG 3 (a thru c)
PRESSURE-TIME RECORDS OF A DIFFRACTED SHOCK





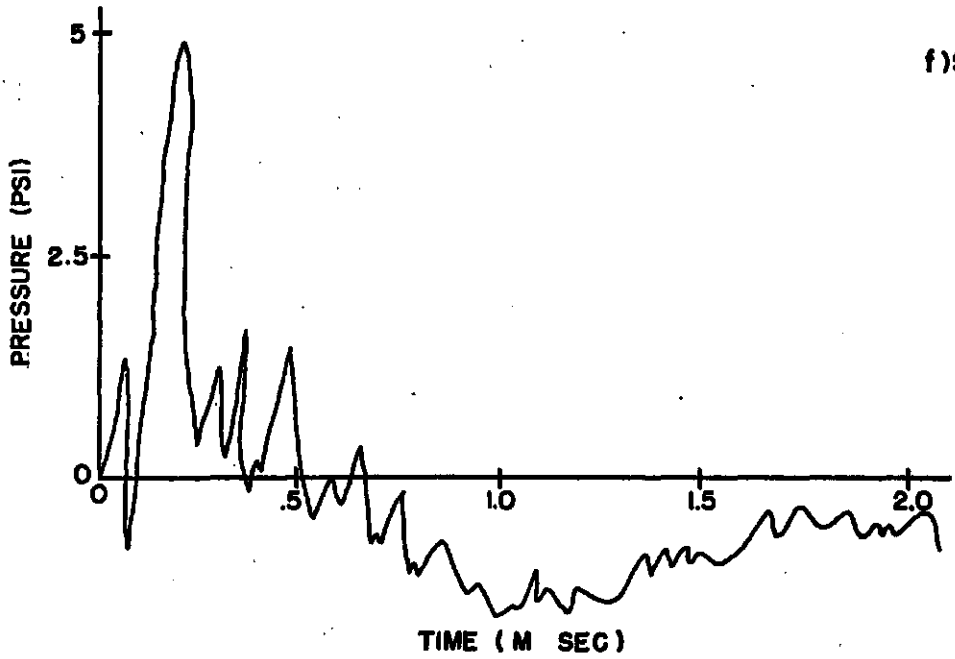


FIG 3 (d thru f)

PRESSURE–TIME RECORDS OF A DIFFRACTED SHOCK

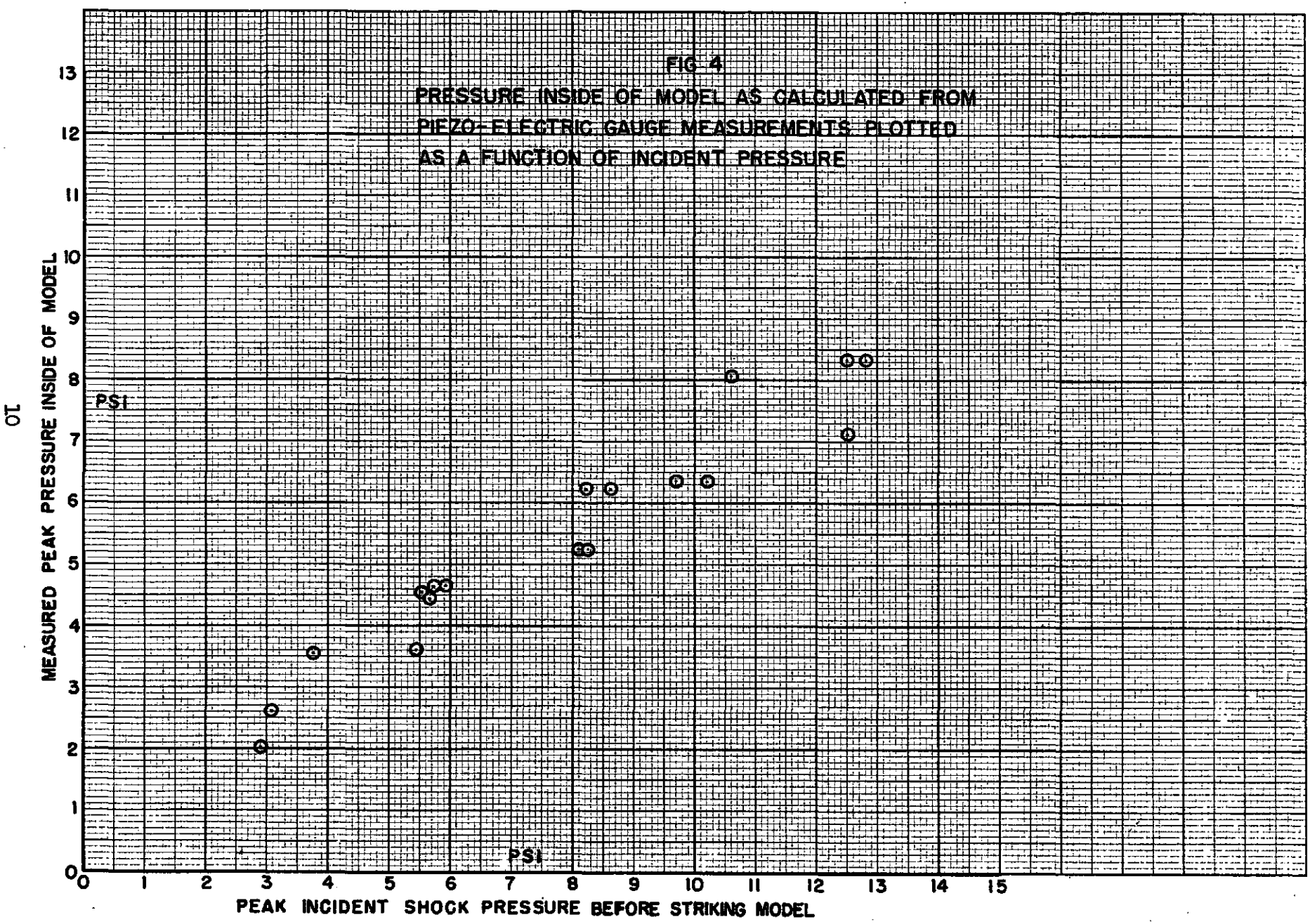


FIG 4
PRESSURE INSIDE OF MODEL AS CALCULATED FROM
PIEZO-ELECTRIC GAUGE MEASUREMENTS PLOTTED
AS A FUNCTION OF INCIDENT PRESSURE
MEASURED PEAK PRESSURE INSIDE OF MODEL
PSI
0
1
2
3
4
5
6
7
8
9
10
11
12
13
PSI
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
PEAK INCIDENT SHOCK PRESSURE BEFORE STRIKING MODEL

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